EMD Oil (Tar) Sands Committee

EMD Oil (Tar) Sands Committee Commodity Report - November, 2012

Debra Higley, Ph.D. ¹, and Fran Hein, Ph.D. ²

November 12, 2012

Contents

Vice-Chairs

Advisory Committee

Introduction

Bitumen Resources and Production

Resource Technology

Environmental Issues

EMD Oil (Tar) Sands Technical Sessions, Publications, and other Products

Selected References

Appendices


B. Web Links for Oil Sands/Heavy Oil Organizations and Publications

¹ U.S. Department of the Interior, U.S. Geological Survey, Denver, Colorado, USA
² Energy Resources Conservation Board, Calgary, Alberta, Canada T2P 3G4
Vice-Chairs:

- Mark Holtz, P.G., P.E. (Vice-Chair: Industry), International Business Development EOR, Praxair, Inc., Austin, TX, US
- Burns Cheadle, Ph.D., P.G. (Vice-Chair: University), University of Western Ontario, London, ON, Canada
- Frances “Fran” Hein, Ph. D. (Vice-Chair: Canadian Government), ERCB, Calgary, AB, Canada
- Debra Higley, Ph.D. (Vice-Chair: US Government) USGS, Denver, Colorado, US
- Mary Harris, Ph.D., P. G., (Vice-Chair: Representative of DEG), Savannah River Nation Laboratory, Aiken, SC, US
- Daniel Tearpoch, CEO (Vice-Chair: Representative of DPA), SCA, LLC, Houston, TX

Advisory Committee:

- Rudolph S. Strobl, P.G., Research Geologist Statoil Canada Ltd, Calgary, AB, Canada
- Paul G. Lillis, Ph.D., Research Geochemist, United States Geological Survey, Denver, CO, US

Introduction
This commodity commonly consists of heavy oil (tar) in unlithified sand; however, heavy oil reservoirs can also include porous sandstone and carbonates. Oil sands petroleum is named bitumen, tar, and extra-heavy oil, although these accumulations can also contain some lighter hydrocarbons and even gas. Bitumen API gravity is less than 10° and viscosity is generally greater than 10,000 centipoises (cP) at reservoir temperature and pressure; heavy oil API gravity is between 10° and 25° with viscosity greater than 100 cP (Danyluk et al., 1984; Schenk et al., 2006). Heterogeneity in reservoirs occurs at microscopic through reservoir scales, and includes sediments of variable depositional energy and hydrocarbon composition. Viscosity gradients of hydrocarbons in the Athabasca oil sands of Alberta primarily reflect differing levels of biodegradation (Adams, 2008; Gates et al., 2008; Larter et al., 2008, Fustic et al., in press). Heavy and extra-heavy oil deposits occur in more than 70 countries across the world, with the largest accumulations located in Canada and Venezuela (Dusseault et al., 2008; Hein and Marsh, 2008; Hernandez et al., 2008; Marsh and Hein, 2008; Meyer et al., 2007; Villarroel, 2008).

**Bitumen Resources and Production**

Almost all of the bitumen being commercially produced in North America is from Alberta, Canada. Canada is an important strategic source of bitumen and of the synthetic crude oil (SCO) obtained by upgrading bitumen. Bitumen and heavy oil are also characterized by high concentrations of nitrogen, oxygen, sulfur, and heavy metals, which results in increased costs for extraction, transportation, refining, and marketing
than for conventional oil (Meyer and Attanasi, 2010). Research and planning are ongoing for transportation alternatives for heavy crude, bitumen, and upgraded bitumen using new and existing infrastructure of pipelines and railways. Such integration has been called a virtual “pipeline on rails” to get the raw and upgraded bitumen to U.S. markets (Perry and Meyer, 2009). Synthetic crude oil from bitumen and (or) partially upgraded bitumen is being evaluated for potential long-distance transport to refineries in the Midwest and Gulf states of the USA and to existing or proposed terminals on the west coast of North America. Associated concerns include effects on the price of crude oil, and the environmental impacts that are associated with land disturbance, surface reclamation, habitat disturbance, and oil spills or leaks with associated potential pollution of surface and ground waters.

A U.S. goal for energy independence could include production from existing U.S. oil sands deposits using surface mining or *in-situ* extraction. Current U.S. bitumen production is mainly for local use on roads and similar surfaces, partly because the states do not have the infrastructure of the Alberta oil sands area. Schenk et al. (2006) listed total measured plus speculative in-place estimates of bitumen at about 54 billion barrels (BB) for 29 major oil sand accumulations in Alabama, Alaska, California, Kentucky, New Mexico, Oklahoma, Texas, Utah, and Wyoming.

Alabama in-place oil sand resources are about 1.76 BB (measured) and 4.6 BB (speculative) from Mississippian sandstone and limestone over an area of about 2 million acres in the northern third of the state (IOCC, 1983). The North Slope of Alaska is estimated to contain 10 BB of in-place tar sand and heavy oils in Cretaceous and Tertiary sands over an area of about 200 square miles of, based on limited data (IOCC, 1983).
The total in-place Alaska resources are 15 BB based on Schenk and others (2006). California in-place oil sand resource estimates are about 1.91 BB measured and 2.56 BB speculative (IOCC, 1983; Schenk and others, 2006). Most of the tar deposits are within Upper Miocene shale to sandstone strata and proximal to the southwest coast (IOCC, 1983). In-place tar resources within Late Mississippian and Early Pennsylvanian sandstone outcrops cover an area of more than 600,000 acres in the western half of Kentucky and are estimated to exceed 1.7 BB (IOCC, 1983) to 3 BB (Noger, 1999). Oil sand accumulations in east central New Mexico total in-place measured and speculative resources of 130 million barrels (MB) and 190 to 220 MB, respectively, within Triassic Santa Rosa Sandstone (IOCC, 1983; Schenk and others, 2006) at depths of less than 2,000 ft. (Broadhead, 1984). Speculative in-place oil sands resources total 800 MB for Oklahoma (IOCC, 1983; Schenk and others, 2006). Oil sands are located mostly within Ordovician Oil Creek Formation sandstones and Viola Group limestones, with lesser accumulations in Mississippian through Permian sandstones (IOCC, 1983). A bibliography of Oklahoma asphalt references through 2006 (B. J. Cardott, compiler) is downloadable from http://www.ogs.ou.edu/fossilfuels/pdf/bibOkAsphalt7_10.pdf.

Measured in-place bitumen in southwestern Texas is 3.87 BB and speculative is 910 to 1,010 MB, from three major deposits in Cretaceous limestone and sandstone (IOCC, 1983; Schenk and others, 2006). Utah has the largest number of occurrences and total size of U.S. oil sands; they are located mainly in the Uinta Basin of northeastern Utah (Blackett, 1996), and in central southeastern Utah (http://geology.utah.gov/emp/tarsand/index.htm). Utah oil (tar) sands in-place resources range from about 11.9 BB measured and 6.8 BB speculative (IOCC, 1983) to 14-15 BB
in place and 23-28 BB potential (Gwynn, 2007; Gwynn and Hanson, 2009). Resources are primarily within Permian, Triassic, Eocene, and Oligocene non-marine sandstones (IOCC, 1983, Gwynn, 2007; Gwynn and Hanson, 2009). In-place resources for two oil sand accumulations in Wyoming total 120 MB measured and 70 MB speculative (IOCC, 1983; Schenk and others, 2006). The larger accumulation is within Pennsylvanian-Permian sandstones of the Minnelusa Formation in northeastern Wyoming, and the smaller is within Cretaceous sandstones in the Wind River Basin, central Wyoming (IOCC, 1983).

Excellent sources of information on Alberta oil sands are the resource assessments and regulatory information by the Alberta Energy Resources Conservation Board (ERCB) (http://www.ercb.ca/portal/server.pt). Estimated in-place resources for the Alberta oil sands are 1804 BB (286.6 billion cubic meters (BCM)) (ERCB, 2010, p. 3). Estimated remaining reserves of in situ and mineable crude bitumen is 168.6 BB (26.8 BCM); only 4.6% of the initial established crude bitumen has been produced since commercial production began in 1967 (ERCB, 2012). Most of the in-place bitumen is within unlithified sands of the Cretaceous McMurray Formation of the Mannville Group. An estimated 64.5 BCM is located within carbonates of the Devonian Grosmont Formation, located mainly within the western Athabasca field (ERCB, 2010). Alberta’s 2007 crude bitumen production totaled 482.5 MB (76.7 million cubic-meters (MCM)), which was equivalent to 1.32 MB per day (210 thousand cubic-meters per day); of this total bitumen production, 59% (284.7 MB) was from surface mining and 41% (197.8 MB) from in-situ production (ERCB, 2008). The bitumen that was produced by surface mining was upgraded to SCO; in-situ bitumen production was marketed as non-upgraded
crude bitumen (ERCB, 2008). Cumulative bitumen production for Alberta in 2009 was 302 MB mined and 245 MB in-situ recovery (48 MCM mined and 39 MCM, respectively) (ERCB, 2010).

Alberta bitumen production has more than doubled in the last decade, and is expected to increase to greater than 3 MB per day (> 0.48 MCM) over the next decade. Over the last 10 years, the contribution of bitumen to Alberta’s total crude oil, raw bitumen, and SCO production has increased steadily. Alberta bitumen and SCO contribution was 62% in 2006, 69% in 2009, and is estimated to reach 86% of cumulative petroleum by 2016, and 89 % by 2019 (ERCB, 2008, 2010). Figure 1 shows the increasing contribution of bitumen and SCO to Alberta’s petroleum supply. This production through time is associated in Figure 2 with SCO price.
Figure 1. Alberta supply of crude oil and equivalents (ERCB, 2010, Figure 3). SCO refers to synthetic crude oil produced from bitumen.

Figure 2. Alberta mined and upgraded bitumen production, and average wellhead crude oil price through time (ERCB, 2012, Figure 6). Start-up times refer to onset of production from various companies and processes.

**Resource Technology**

As of December 2008, Alberta bitumen reserves under active development (mainly by surface mining) accounted for only 15% of the remaining established reserves of 21 BB (3.3 BCM). Unlocking the huge potential of the remaining bitumen resources will require enhancing other *in-situ* technologies. The most commonly used *in-situ* technologies are Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation
(CSS). SAGD and CSS utilize considerable energy and water to produce steam; also required are good permeability (both vertical and horizontal), relatively thick pay zones (> 10 m), and an absence of barriers (cemented zones, thick laterally-continuous shales) and the lack of significant top/gas, top/lean or bottom water thief zones. Generally the cross-bedded sands of lower point bar depositional environments are characterized by vertical permeability ranging from 2 to 6 Darcie (D). Associated inclined heterolithic stratification (IHS) from upper point bar deposits exhibit a 2 to 3 order of magnitude decrease in permeability, and siltstone in abandoned channel and point bar strata exhibit a 2 to 3 order-of-magnitude decrease in permeability (Strobl et al., 1977; Strobl, 2007, Strobl, in press). Depositional heterogeneities at vertical and lateral scales influence bitumen recovery from in-situ processes. A comprehensive, two-volume edition book entitled: “Handbook on theory and practice of bitumen recovery from Athabasca oil sands” (Masliyah et al., 2011) focuses on the extraction of bitumen from oil sands mainly using surface mining methods, and also includes a chapter on in-situ processes. Volume I covers the basic scientific principles of bitumen recovery, froth treatment, diluents recovery, and tailings disposal; Volume II is devoted to industrial practices (editor, Jan Czarnecki, at jc7@ualberta.ca). Some of the focus of recent in-situ technology and advances includes:

- Integration of future oil sands technology with that of emerging oil shale co-production in the western United States
- New developments concerning in-situ recovery and underground refining technologies for oil sands in western Canada include underground combustion and refining
• Use of Cold Heavy Oil Production with Sand (CHOPS) as a specialized primary type of production where progressive cavity pumps assist in lifting bitumen and sand to the surface, and utilize this sand production to create wormholes in the strata to increase permeability in the reservoir.

• Search for alternative sources of energy for steam production, including the use of nuclear energy in conjunction with *in-situ* oil sands production plants (Peace River, Alberta).

• Further development and integration of technologies that include solvent co-injection, electro-magnetic heating, wedge (in-fill) wells, in-situ combustion, hot-solvent gravity drainage, Supercritical Partial Oxidation (SUPOX), and various hybrid developments, including CO₂ flooding (Rudy Strobl, Nov. 14, written communication).

Critical technology needs include enhancing current methods and developing new more-environmentally-friendly methods of extraction, production, and upgrading of oil sands. Emphasis of surface mining operations is on reclamation of tailings and consolidated tailings, and on re-vegetation of open-pit mine sites. In early February 2009, the Energy Resources Conservation Board (ERCB) issued Directive 074 that outlines new cleanup rules and harsh penalties for non-compliance regarding tailings ponds regulations for the oil sands areas. This directive resulted from the ERCB acknowledgment that, although operators invested heavily in improved tailings reduction strategies, targets set out in the original development applications have not been met.
Firm performance criteria are defined for reclaiming the tailings ponds, with performance inspections, and subsequent penalties due to neglect, omission, or commission.

Most of the bitumen resources are extracted by *in-situ* technologies (mainly thermal, such as Steam Assisted Gravity Drainage and Cyclic Steam Stimulation). Because there is significant co-production of greenhouse gases with bitumen production and upgrading, critical technology needs involve research into: 1) alternative sources of heat for generation of steam (e.g., geothermal, nuclear, burning of slag); 2) methods to reduce the viscosity of the bitumen so it will flow to the well bore or through pipelines more easily (such as use of diluents, catalysts, microbial and nanotechnology); 3) underground *in-situ* extraction, refining, and upgrading; and 4) co-sequestration of greenhouse gases by injection into abandoned reservoirs or other deep geologic sites. There was in the past an excess supply of produced sulfur, above what was used in agricultural and other markets. Excess sulfur is stockpiled from bitumen and sour gas production and refining. Produced and stored sulfur is sold to various markets, the largest being China, mainly converted to sulfuric acid for use in manufacturing phosphate fertilizer (ERCB, 2012).

**Environmental Issues**

The primary environmental issues relate to the balance among greenhouse gas emissions and water/energy usage and the recovery, production and upgrading of bitumen. Specifically, the critical environmental focus is how to cleanly, efficiently, and safely extract, produce, and upgrade the bitumen. Goals include reducing (1) energy
required to heat the water to steam and (2) CO\(_2\) emissions. Current greenhouse gas emissions are decreasing and remaining emissions are compensated for by carbon trading and (or) CO\(_2\) sequestration; and (3) improving the economics and processes of extraction, production and upgrading of the bitumen. Some of the areas of focus include

- Land reclamation in surface mining
- Tailings and consolidated tailings disposal and reclamation
- Bitumen upgrading and co-production of other products from tailings (such as vanadium, nickel, and sulfur)
- *In-situ* recovery
- Underground refining.

Oil sand developers in Canada are focused on reducing CO\(_2\) emissions by 45% per barrel by 2010, as compared to 1990 levels. Also in Canada, developers are legislated to restore oil sand mining sites to at least the equivalent of their previous biological productivity. For example, at development sites near Fort McMurray, Alberta, the First Nation aboriginal community, as part of the Athabasca Tribal Council, and industry have worked together to reclaim disturbed land (Boucher, 2012) and industry has reclaimed much of the previous tailings pond areas into grasslands that are now supporting a modest bison herd (~ 500 – 700 head).

**EMD Oil (Tar) Sands Technical Sessions, Publications, and other Products**
AAPG Studies in Geology 64 entitled “Heavy-oil and oil-sand petroleum systems in Alberta and beyond” is in the final stage of production. This oil sands and heavy oils research includes presentations from the 2007 Hedberg conference in Banff, Canada titled “Heavy oil and bitumen in foreland basins – From processes to products.” Publication editors are Frances Hein, Dale Leckie, Steve Larter, and John Suter. Contained are 28 chapters (Appendix A) that encompass depositional settings of oil sands and heavy oil accumulations, reservoir characterizations, geochemical characteristics of bitumen and of oil biodegradation, geologic and petroleum system modeling, petroleum reserves and resources, surface mining and in-situ production processes, such as SAGD, for accumulations in Canada, Russia, the United States, and Venezuela, and oil sands tailings and water use management.

The April, 2012 AAPG National Convention in Long Beach, California included an EMD-sponsored poster session titled “Heavy oil and oil shale.” This thermal-maturation cradle-to-grave theme included petrographic and stratigraphic features of oil shale and heavy oil sources and hosts, and production techniques for and fracture characteristics of heavy oil reservoirs. The Higley and Hein (2011) AAPG Natural Resources Research paper contained resource information on oil sands. On Sept. 20th, 2011, an email blast to AAPG members was written by Debra Higley; the provided information included resources located on the AAPG/EMD Oil (Tar) Sands site and works in progress. Frances Hein, previous Chair of the EMD Oil (Tar) Sands Committee, was the AAPG EMD co-chair for the AAPG International Conference & Exhibition (ICE), held in Calgary in September, 2010. EMD-sponsored sessions included a full day on unconventional resources, which included morning and afternoon
sessions on Heavy Oil/Bitumen and the Bakken, and a plenary talk by Dr. Dale Leckie on Nexen’s Long Lake SAGD project in northern Alberta. At the 2009 AAPG Annual Meeting in Denver the Energy Minerals Division (EMD) of AAPG poster session on oil (tar) sands was part of the unconventional resources sessions; a similar EMD session was included in the 2010 AAPG Annual Meeting in New Orleans.

**Selected References**


Bellman, L., 2009, Improvements in oil sands reservoir characterization: Presentation and panel discussion, Canadian Heavy Oil Association, Beer and Chat, Petroleum Club, Calgary, AB, May 28, 2009: office@choa.ab.ca


Keyser, T., 2009, An answer at hand? Since the dawn of oil sands mining, the search has been on for a better way to deal with tailings. One answer could prove to be biopolymer beads small enough to hold in your palm: Business article in the PEGG, May 2009, p. 25: www.apegga.org.


http://energy.cr.usgs.gov/oilgas/addoilgas/WEC10NBEHO.pdf


Perry, G. and Meyer, R., 2009, Transportation alternatives for heavy crude and bitumen: Canadian Heavy Oil Association, Beer and Chat, Petroleum Club, Calgary, AB, April 28, 2009: office@choa.ab.ca


Strobl, R.S., (in press), Integration of steam-assisted gravity drainage fundamentals with reservoir characterization to optimize production, in, Frances J. Hein, Dale Leckie, Steve


Appendices


Table of Contents

Chapter 1. ................................................................. 1
Heavy Oil and Bitumen Petroleum Systems in Alberta and Beyond: The Future Is Nonconventional and the Future Is Now

*Frances J. Hein, Dale Leckie, Steve Larter, and John R. Suter*

**Chapter 2.** The Dynamic Interplay of Oil Mixing, Charge Timing, and Biodegradation in Forming the Alberta Oil Sands: Insights from Geologic Modeling and Biogeochemistry

*Jennifer Adams, Steve Larter, Barry Bennett, Haiping Huang, Joseph Westrich, and Cor van Kruisdijk*

**Chapter 3.** Geologic Reservoir Characterization and Evaluation of the Petrocedeño Field, Early Miocene Oficina Formation, Orinoco Heavy Oil Belt, Venezuela

*Allard W. Martinius, Jan Hegner, Inge Kaas, Celia Bejarano, Xavier Mathieu, and Rune Mjøs*

**Chapter 4.** The Alberta Oil Sands: Reserves and Long-term Supply Outlook

*Farhood Rahnama, Richard A. Marsh, and LeMoine Philp*

**Chapter 5.** Comparison of Oil Generation Kinetics Derived from Hydrous Pyrolysis and Rock-Eval in Four-Dimensional Models of the Western Canada Sedimentary Basin and Its Northern Alberta Oil Sands

*Debra K. Higley and Michael D. Lewan*

**Chapter 6.** Impact of Reservoir Heterogeneity and Geohistory on the Variability of Bitumen Properties and on the Distribution of Gas- and Water-saturated Zones in the Athabasca Oil Sands, Canada
Chapter 7. A Regional Geologic Framework for the Athabasca Oil Sands, Northeastern Alberta, Canada

Frances J. Hein, Graham Dolby, and Brent Fairgrieve

Chapter 8. The Significance of Palynofloral Assemblages from the Lower Cretaceous McMurray Formation and Associated Strata, Surmont, and Surrounding Areas in North-central Alberta

Graham Dolby, Thomas D. Demchuk, and John R. Suter

Chapter 9. Stratigraphic Architecture of a Large-scale Point-bar Complex in the McMurray Formation: Syncrude’s Mildred Lake Mine, Alberta, Canada


Chapter 10. Depositional Setting and Oil Sands Reservoir Characterization of Giant Longitudinal Sandbars at Ells River: Marginal Marine Facies of the McMurray Formation, Northern Alberta Basin, Canada

Paul L. Broughton

Chapter 11. Advanced Seismic-stratigraphic Imaging of Depositional Elements in a Lower Cretaceous (Mannville) Heavy Oil Reservoir, West-central Saskatchewan, Canada

Sabrina E. Sarzalejo Silva and Bruce S. Hart
Chapter 12. .................................................................................................................. 373
Oil-saturated Mississippian–Pennsylvanian Sandstones of South-central Kentucky
Michael T. May

Chapter 13. .................................................................................................................. 407
Overview of Heavy Oil, Seeps, and Oil (Tar) Sands, California
Frances J. Hein

Chapter 14. .................................................................................................................. 437
Unconventional Oil Resources of the Uinta Basin, Utah
Steven Schamel

Chapter 15. .................................................................................................................. 481
Integrated Reservoir Description of the Ugnu Heavy-oil Accumulation, North Slope, Alaska
Erik Hulm, Greg Bernaski, Boris Kostic, Steve Lowe, and Rick Matson

Chapter 16. .................................................................................................................. 509
Overview of Natural Bitumen Fields of the Siberian Platform, Olenek Uplift, Eastern Siberia, Russia
Vladimir A. Kashirtev and Frances J. Hein

Chapter 17. .................................................................................................................. 531
Multiple-scale Geologic Models for Heavy Oil Reservoir Characterization
Clayton V. Deutsch

Chapter 18. .................................................................................................................. 545
Modeling of a Tide-influenced Point-bar Heterogeneity Distribution and Impacts on Steam-assisted Gravity Drainage Production: Example from Steepbank River, McMurray Formation, Canada
Geoffray Musial, Richard Labourdette, Jessica Franco, Jean-Yves Reynaud
Chapter 19. ................................................................. 565
Modeling by Constraining Stochastic Simulation to Deterministically Interpreted Three-dimensional Geobodies: Case Study from Lower Cretaceous McMurray Formation, Long Lake Steam-assisted Gravity Drainage Project, Northeast Alberta, Canada
Milovan Fustic, Dany Cadiou, Dave Thurston, Adal Al-Dliwe, and Dale A. Leckie

Chapter 20. ................................................................. 605
Spectral Decomposition in a Heavy Oil and Bitumen Sand Reservoir
Carmen C. Dumitrescu and Larry Lines

Chapter 21. ................................................................. 625
Fundamentals of Heat Transport at the Edge of Steam Chambers in Cyclic Steam Stimulation and Steam-assisted Gravity Drainage
Ian D. Gates, Marya Cokar, and Michael S. Kallos

Chapter 22. ................................................................. 639
Integration of Steam-assisted Gravity Drainage Fundamentals with Reservoir Characterization to Optimize Production
Rudy Strobl

Chapter 23. ................................................................. 655
Screening Criteria and Technology Sequencing for In-situ Viscous Oil Production
Maurice B. Dusseault

Chapter 24. ................................................................. 669
New Progress and Technological Challenges in the Integral Development of the Faja Petrolifera del Orinoco, Venezuela
Teófilo Villarroel, Adriana Zambrano, and Rolando Garcia

Chapter 25. ................................................................. 689
Trading Water for Oil: Tailings Management and Water Use in Surface-mined Oil Sands

*Randy Mikula*

**Chapter 26.** ................................................................. 701

Potential Role of Microbial Biofilms in Oil Sands Tailings Management

*Victoria Kostenko and Robert John Martinuzzi*

**Chapter 27.** ................................................................. 725

Geothermal Energy as a Source of Heat for Oil Sands Processing in Northern Alberta, Canada

*Jacek Majorowicz, Martyn Unsworth, Tom Chacko, Allan Gray, Larry Heaman, David K. Potter, Doug Schmitt, and Tayfun Babadagli*

**Chapter 28.** ................................................................. 747

Joslyn Creek Steam-assisted Gravity Drainage: Geologic Considerations Related to a Surface Steam Release Incident, Athabasca Oil Sands Area, Northeastern Alberta, Canada

*Frances J. Hein and Brent Fairgrieve*

**Appendix B: Web Links for Oil Sands/Heavy Oil Organizations and Publications**

The following provides updates to the Members-Only Webpage located at

http://emd.aapg.org/members_only/oil_sands/index.cfm

Alabama Geological Survey website: http://www.gsa.state.al.us

Alaska Division of Geological and Geophysical Surveys: http://www.dggs.dnr.state.ak.us
Alberta Energy Resources Conservation Board (ERCB): [www.ercb.ca](http://www.ercb.ca)

Alberta Chamber of Resources: [www.abchamber.ca](http://www.abchamber.ca)

Alberta Department of Energy: [www.energy.gov.ab.ca](http://www.energy.gov.ab.ca)

Alberta Department of Sustainable Resource Development: [www.srd.alberta.ca](http://www.srd.alberta.ca)

Alberta Innovates – Energy and Environmental Solutions: [www.albertainnovates.ca/energy/](http://www.albertainnovates.ca/energy/)

Alberta Environment Information Centre: [www.environment.gov.ab.ca](http://www.environment.gov.ab.ca)

Alberta Geological Survey: [www.ags.gov.ab.ca](http://www.ags.gov.ab.ca)

Alberta Government: [www.alberta.ca](http://www.alberta.ca)

Alberta’s Industrial Heartland Association: [www.industrialheartland.com](http://www.industrialheartland.com)

Alberta Ingenuity Centre for In Situ Energy: [www.aicise.ca](http://www.aicise.ca)

Alberta Innovation & Science: [www.aet.alberta.ca](http://www.aet.alberta.ca)
Alberta Research Council: [www.arc.ab.ca](http://www.arc.ab.ca)

Alberta Sulphur Research Ltd.: [www.chem.ucalgary.ca/asr](http://www.chem.ucalgary.ca/asr)

Athabasca Regional Issues Working Group: [www.oilsands.cc](http://www.oilsands.cc)


Canadian Association of Petroleum Producers: [www.capp.ca](http://www.capp.ca)

Canadian Energy Research Institute: [www.ceri.ca](http://www.ceri.ca)

Canadian Geoscience Council: [www.geoscience.ca](http://www.geoscience.ca)

Canadian Heavy Oil Association: [www.choa.ab.ca](http://www.choa.ab.ca)

Canadian Institute of Mining, Metallurgy & Petroleum: [www.cim.org](http://www.cim.org)

Canadian Petroleum Institute: [www.cppi.ca](http://www.cppi.ca)

Canadian Society of Petroleum Geologists: [www.cspg.org](http://www.cspg.org)
Canadian Well Logging Society: www.cwls.org

CanMet Mining and Mineral Sciences Laboratories: www.nrcan.gc.ca

Careers: The Next Generation: www.nextgen.org

Climate Change Central: www.climatechangecentral.com

EnergyInet: www.energyinet.com

Environment Canada: www.ec.gc.ca

Fort McMurray Chamber of Commerce: www.fortmcmurraychamber.ca

Freehold Owners Association: www.fhoa.ca


Institute for Sustainable Energy, Environment and Economy: www.iseee.ca

International Energy Foundation: www.ief-energy.org

National Energy Board: www.neb-one.gc.ca
National Research Council’s Industrial Research Assistance Program: www.irap-pari.nrc-cnrc.gc.ca

Natural Resources Canada: www.nrcan-rncan.gc.ca

New Mexico Bureau of Geology and Mineral Resources: http://geoinfo.nmt.edu/index.html

Oklahoma Geological Survey http://www ogs.ou.edu/homepage.php

Oil Sands Discovery Centre: www.oilsandsdiscovery.com


Petroleum Technology Alliance Canada: www.ptac.org

Petroleum Technology Research Centre: www.ptrc.ca

Saskatchewan Industry and Resources: www.ir.gov.sk.ca

Saskatchewan Government: www.ir.gov.sk.ca
Saskatchewan Research Council: www.src.sk.ca

Seeds Foundation: www.seedsfoundation.ca

Small Explorers and Producers Association of Canada: www.sepac.ca

Society of Petroleum Engineers: www.speca.ca

The Canadian Society of Exploration Geophysicists: www.cseg.ca

The Environmental Association of Alberta: www.esaa.org

U.S. Energy Information Administration: www.eia.doe.gov,
http://search.usa.gov/search?affiliate=eia.doe.gov&v%3Aproject=firstgov&query=oil+sands


U.S. Bureau of Land Management: www.blm.gov

Utah Heavy Oil: http://www.heavyoil.utah.edu/outreach.html;
http://map.heavyoil.utah.edu/
Utah Geological Survey: Tar Sands Information.

http://geology.utah.gov/emp/tarsand/index.htm